1997 Annual Report

NCEMT

National Center for Excellence in Metalworking Technology

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE **National Center for Excellence in Metalworking Technology (NCEMT) 1997 Annual Report**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Concurrent Technologies Corporation,NCEMT Information Services,1450 Scalp Avenue,Johnstown,PA,15904**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**20**	

LETTERS

Today, more than ever, the Navy considers risk reduction one of its top priorities when adopting new technology, whether for ships, submarines, aircraft or ordnance. In response, the National Center for Excellence in Metalworking Technology (NCEMT) continues to enhance manufacturing practices that reduce risk in fielding Navy weapons systems.

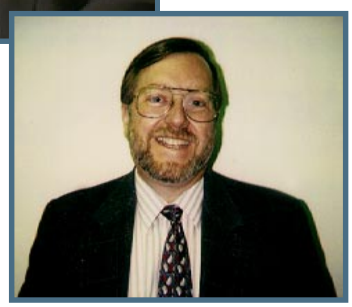
The NCEMT approach tailors existing commercial technology for defense applications. This approach enables the U.S. defense industrial base to incorporate advanced technologies into its manufacturing processes, thus increasing the quality and reliability of components; all of which translate into significant risk reductions for the Navy and DOD.

In this annual report I am proud to present some of the NCEMT accomplishments that illustrate the successful achievement of these risk-reducing goals.

The many success stories showcased in this annual report were made possible in great part by numerous alliances with military and industrial partners. Through varied partnerships with the Navy, the other services, and U.S. industry, the NCEMT is strongly positioned as a national resource for implementing emerging manufacturing technologies.

As always, I extend to everyone an open invitation to learn more about the NCEMT and how your organization can benefit from metalworking solutions developed under the U.S. Navy Manufacturing Technology (MANTECH) Program. You can depend on our expertise and our consistent investment in state-of-the-art capabilities to provide practical solutions of the highest quality at the lowest cost.

Richard J. Henry
NCEMT Program Manager



The MANTECH Program provides a mechanism for developing enabling manufacturing technology, in the form of new equipment and processes, and implementing them in DOD weapons systems production lines. While cost reduction is essential, it is critical to minimize the risk of adopting new technology. The MANTECH Program relies on the NCEMT and the other Centers of Excellence as cornerstones to meet this objective.

The NCEMT specifically accomplishes this goal by enabling the practice of advanced metalworking processes, methods, techniques, and equipment; maximizing dissemination of results to industry; and stimulating industry to invest in and implement new technologies.

Through its activities, the NCEMT exemplifies the Navy MANTECH Program's commitment to sustain a responsive world-class manufacturing capability to affordably meet the warfighters' needs today, and throughout the life-cycle of a defense system.

Steven Linder
Director, Navy Industrial Programs
Office of Naval Research
Manufacturing Science and Technology

The NCEMT was established in 1988 by the MANTECH Program to provide the Navy, the other services, and the U.S. defense industrial base with a single source of metalworking expertise. The NCEMT fulfills this objective by providing innovative, cost-effective manufacturing solutions that ensure top performance and reliability from weapons systems.

Since its inception, the NCEMT has utilized concurrent engineering techniques for developing affordable solutions to Navy metalworking problems. Rational Product & Process Design® (R·P^{2}D®) is a concurrent engineering methodology that enforces a focus on quality throughout the design, production, performance, and recycle phases of a component. This technique, utilizing state-of-the-art problem solving tools, leads to life-cycle cost savings, optimized manufacturing processes, reconfigurable products, and more durable components with reduced sustainment requirements.

For example, computer aided engineering (CAE) tools enable the design and manufacturing process for components and complex assemblies to be optimized within a computer environment, prior to being released to the shop floor for fabrication. Application of these tools not only reduces lead time but improves productivity and quality as well.

Materials characterization, which involves assessing and documenting the microstructural changes that take place in a material during manufacturing, provides another optimization tool. These materials data enable design engineers to tailor properties to application-specific requirements and, ultimately, to optimize component performance.

Process control procedures and process simulation models using numerical and analytical techniques are key risk reduction tools. Intelligent processing of materials (IPM) techniques combine these tools to measure product characteristics during processing and then instantaneously adjust the process to optimize part quality, performance, and cost. This increases the yield of acceptable product and ensures efficient use of the most expensive materials.

Demonstration factories link computer simulation and the production floor. By operating production equipment in a controlled environment, the NCEMT provides a cost-effective means testing, and evaluating new processing methods, thus verifying that they are applicable to the factory floor. NCEMT demonstration factories include sheet metal forming, wire drawing, forging, powder metal compaction, powder injection molding, welding, and semi-solid metalworking.

As an integral part of its concurrent engineering strategy, the NCEMT forms partnerships with the Navy's technical community, the other services, industry, and academia. Working in integrated project teams selected specifically for the manufacturing challenge at hand enables the NCEMT to build on existing technology to help its industrial partners readily implement cost-saving technologies.

As part of this integrated project team effort, the NCEMT disseminates leading-edge technologies through workshops, users groups, and Engineering Knowledge Bases (EKB) accessible through the World Wide Web.

Consistent with the Navy's need to reduce risks in fielding improved weapons systems, the NCEMT serves as a bridge for emerging technologies, connecting partners from both the military and industry to implement verified manufacturing solutions at the lowest cost.

From a broad range of potential partners, the NCEMT selects project teams uniquely suited to each specific manufacturing challenge. These integrated project teams include members from Naval and DOD laboratories, industry, and academia. This approach enables the NCEMT to bring together the precise expertise and resources needed to ensure top quality and cost-effectiveness.

The NCEMT Engineering Knowledge Bases (EKB)

The NCEMT Engineering Knowledge Bases (EKB) can be accessed over the Internet. Located on the NCEMT Information Server, these EKBs include a wealth of information on formability, P/M materials, porous materials, high temperature superconductor manufacture, and thermophysical properties. Users may register on-line for access (www.ncemt.ctc.com).

For example, the NCEMT is working closely with two Naval Surface Warfare Centers: Carderock Division and Port Hueneme Division, as well as industry to ensure the implementation of centrifugally cast drums for anti-slack devices and winches. Field tests performed at Port Hueneme had shown that drums made from nickel aluminum bronze containing wear resistant titanium carbide particles have the potential to outperform the materials presently in use. However, difficulties have been encountered in manufacturing the drums to a consistent quality level. Teaming with Port Hueneme and Carderock Division (developer of the material), Wisconsin Centrifugal Castings (manufacturer of the drums) has provided the NCEMT with the resources to ensure successful transition of this materials development to shipboard use.

Similarly, the NCEMT, the U.S. Army-Picatinny Arsenal, the Surface Engineering and Manufacturing Technology Center at Pennsylvania State University, and Hart Metals, Inc., have teamed to optimize magnesium atomization technology. Sophisticated numerical analysis tools, developed by NIST and NASA, are being adapted to optimize the gas flow and the temperature fields during atomization; this will ultimately increase powder yield, improve powder quality, and significantly reduce production costs. The resulting optimized process will enable the cost-effective production of atomized magnesium powder for both defense and commercial purposes.

In a joint effort with NSWC Carderock and Newport News Shipbuilding, the NCEMT used numerical modeling tools to optimize welding parameters in the fabrication of submarines. This approach led to the certification of a cost-effective, undermatched welding system for the Seawolf and New Attack Submarine (NSSN) pressure hulls. The process is being further developed for other NSSN applications.

Working in integrated project teams allows the NCEMT to modify existing technologies for specific DOD applications and to disseminate enabling technologies for multiple applications to the entire defense industry.

For example, in conjunction with the Program Executive Office-Theater Air Defense, the NCEMT is developing advanced gun barrel technology to improve the performance of medium caliber weapons. A new refractory metal alloy developed for Navy nuclear applications is being evaluated as a liner for high-performance barrels. Combining the manufacturing expertise of General Dynamics Armament Systems with the test firing capabilities of Picatinny Arsenal enables the NCEMT to demonstrate the feasibility of producing refractory lined gun barrels. This technology will allow the safe use of higher impetus ammunition, thereby enabling warfighters from all services to achieve more ordnance on target, at greater stand-off distance.

Atlas of Formability

The Atlas of Formability EKB, located on the NCEMT Information Server (www.ncemt.ctc.com), provides mechanical and microstructural data on more than 150 materials used in forming weapons systems components. Accessible over the Internet, the Atlas EKB provides a value-added interface that allows process engineers to compare, analyze, and generate customized reports of formability data.

A major Navy supplier estimates that using Atlas of Formability data contributed to the reduction of its forging development costs by 60%. Another company supplying the Navy with propulsion shafts, anticipates eliminating forging trials almost entirely by incorporating Atlas of Formability data into its product and process design approach.

PARTNERSHIPS

Thermophysical Properties

The Thermophysical Properties (TP) EKB, located on the NCEMT Information Server (www.ncemt.ctc.com), provides reliable data for the modeling, control, and optimization of metalworking processes used in the production of Navy components. Designed to improve the delivery of TP data to the Navy, DOD, and their vendors, this EKB allows registered users to search and compare TP information and obtain reports on-line, over the Internet. When integrated in process simulation, the TP data enables the manufacturing engineer to predict and readily remediate product defects.

The NCEMT forges partnerships with industry to broaden the implementation of more cost-effective technical developments in production. For example, through a team effort with leading investment casting foundries, PCC Airfoils and Howmet, the NCEMT developed the methodology to optimize the solution heat treatment of single crystal turbine airfoils. This technology has not only been implemented in the production of Navy turbine engines for the F/A-18 Hornet and F-14 Tomcat fighters, but, under private funding, has been expanded and applied to commercial engines as well.

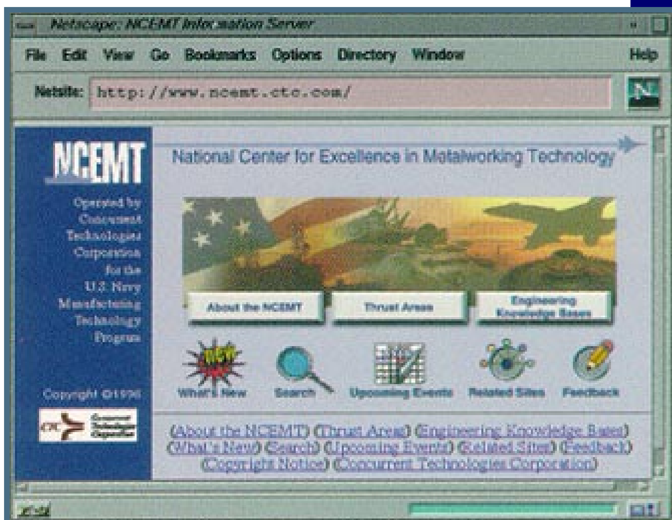
In another alliance with industrial partners, GE Aircraft Engines and Allvac, the NCEMT is developing the technology to

SSM Users Group Meeting

On October 15 and 16, 1996, the NCEMT sponsored the Fifth Semi-Solid Metalworking (SSM) Users Group Meeting with sixty industry representatives attending. Featured presentations focused on the work to upgrade the NCEMT SSM facility to process titanium. This upgrade includes an improved induction heating system and increased injection and intensification pressures. Also featured were five presentations by industrial representatives which summarized their developments as well as their implementation of NCEMT developments at their facilities.

optimize the plasma arc melting (PAM) process, thus reducing the cost of producing consistently defect-free titanium jet engine components, such as compressor disks and blades.

The NCEMT also offers its partners the opportunity to evaluate and optimize new processes in an NCEMT demonstration factory, thus avoiding expensive trial-and-error on the shop floor. The NCEMT semi-solid metalworking (SSM) demonstration factory, for example, has been used to support the implementation of this emerging manufacturing process for automotive components. To facilitate broader use of the SSM manufacturing process, the NCEMT has formed a users group of over forty industrial and government organizations who meet regularly to share technological developments and provide guidance for ongoing NCEMT SSM efforts. Several members of the SSM users group have implemented NCEMT-developed technology in their own production facilities. ■



NCEMT World Wide Web

The NCEMT World Wide Web Information Service provides an overview of the NCEMT and its technical thrust areas, information on upcoming events, lists of technical presentations and publications, and technology demonstrations. Registered users also can access Engineering Knowledge Bases (EKB) which provide detailed technical information to help optimize various manufacturing processes.

The NCEMT Information Server is located at: www.ncemt.ctc.com

SHIPS

In modern Navy ship design, increasing importance is placed upon maintaining or improving operational capability while reducing initial fabrication and life-cycle costs. To meet this objective, the NCEMT is building on past successes in improving weld fabrication processes to continue its development of lower-cost alternatives to conventional practices used in building Navy steel structures.

To meet future Navy requirements, steels with higher strength levels, which enable reduced section thickness, must be utilized. Although steel companies have demonstrated the ability to produce these steels, cost-effective fabrication procedures have not been defined.

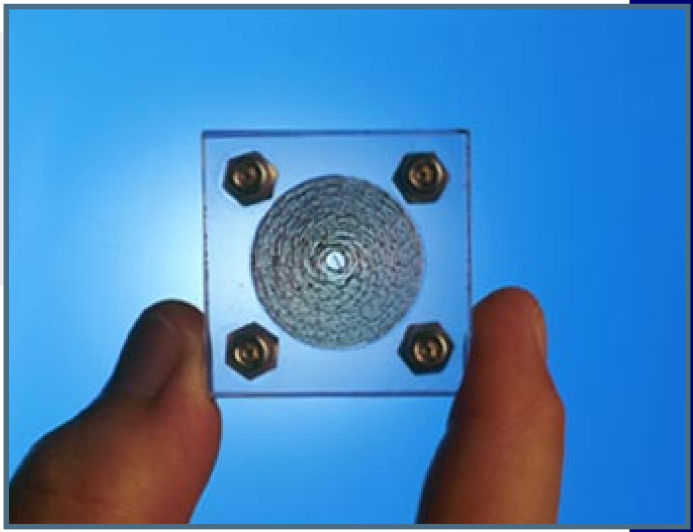
To satisfy this need, the NCEMT is developing welding procedures to ensure structural integrity when welding HSLA-65 steel with 70ksi-series consumables. This technology will provide reduced weight ship structures and will result in significant savings in both acquisition and life-cycle costs. Newport News Shipbuilding estimates a 2400-ton weight savings and a potential life-cycle savings of $24M with the use of HSLA-65 in the CVN-77.

Ship fabrication costs can also be reduced by introducing an advanced MIL-100S weld wire composition for high-strength steels. The high cost of fabrication is partly due to production delays resulting from preheating required to ensure resistance to hydrogen embrittlement and hydrogen-assisted cracking (HAC). Building on prior results and working closely with the Navy Task Force on Advanced Filler Materials, the NCEMT has evaluated consumables which are more resistant to HAC and achieve the required strength and toughness criteria when welded without preheat. When mature, this technology will be demonstrated and implemented in the CVN-77 aircraft carrier, ultimately resulting in a savings of $13M in fabrication costs.

Maintaining and improving operational capability while reducing life-cycle costs can also be achieved in support systems. For example, the NCEMT is resolving quality problems in centrifugally casting TiC/bronze drums for hauling winches and anti-slack devices. The resulting robust and repeatable manufacturing process will provide drums with significantly improved wear resistance that can reliably withstand challenging operational conditions. Implementation in the Underway Replenishment Fleet is expected to result in an annual savings of $25M.

Significant savings are also anticipated through the manufacture by semi-solid metalworking (SSM) of titanium-based fluid handling components. All-up titanium fluid handling systems can significantly reduce the cost of maintenance, repair, and replacement of sea water and sewage systems of Navy ships; however, titanium currently requires more expensive manufacturing processes than copper-nickel alloys. The NCEMT, in conjunction with the Auxiliary Systems Group (Code 03L4) and Naval Sea Systems Command (NAVSEA), is optimizing product and manufacturing procedures for the cost-effective titanium fluid handling components. Application of the SSM process to valves and fittings for the piping system of the LPD-17, an amphibious assault ship, will result in estimated savings of $1,200 to $10,000 per valve. This will allow the Navy to install titanium alloy systems at costs equivalent to copper-nickel, yet with superior life-cycle performance. Over the 40-year life span of the LPD-17, maintenance costs are expected to be reduced by $13M.

The NCEMT is also developing technologies to reduce risk in fielding mine warfare components. For example, in conjunction with the Naval Surface Warfare Center, Carderock Division (NSWC/CD), the NCEMT is developing a cost-effective manufacturing process for aluminum stabilized superconductor wire. This wire is a critical component of large-scale magnets for the Advanced Lightweight Influence Sweep System (ALISS) used for mine detection. Because the weight of the ALISS must be as low as possible, use of aluminum-stabilized niobium-titanium superconducting wire enables it to be reduced significantly without sacrificing stability. This improved manufacturing technology will result in cost savings of 30–40% over the presently used co-extrusion cladding process. These improved superconducting wires meet performance requirements, offer a 40–50% weight reduction, and provide ten times the thermal stability of equally sized, copper stabilized superconducting wires.



The NCEMT developed and demonstrated the effectiveness of a novel rolling process for neodymium ribbons. This roll-embossed ribbon, used in the ALISS regenerative heat exchanger, provides better heat transfer properties, lower pressure drop characteristics, and reduced thermodynamic losses. Tests conducted at NSWC/CD confirmed a 75% increase in refrigeration capacity. ■

SUBMARINES

The NCEMT is developing fabrication technologies to reduce the cost of manufacturing submarine components, while still satisfying rigorous performance requirements and structural integrity.

Naval vessels fabricated from higher strength steels traditionally require higher yield strength (overmatching) weld consumables, necessitating restrictive welding procedures which add significantly to fabrication costs. Previously, the NCEMT, working with the Naval Surface Warfare Center, Carderock Division, optimized the use of undermatched weldments for fabrication of submarine hulls; this allows a wider choice of available welding consumables. These findings have been incorporated into a new NAVSEA specification which certifies the use of undermatched weldments for submarine pressure hulls. On the New Attack Submarine (NSSN) hull, this will save an estimated $3M through improved welding productivity due to higher deposition rates and greater availability of commercial welding consumables. This technology is now being enhanced for use in NSSN applications which are subject to complex loading.

The cost of building submarines can also be reduced by lowering the cost of system components. For example, the hot isostatic pressing (HIP) process can produce cost-effective, high-quality, high-performance components; however, the use of this process has been limited by excessive lead times and costly trial-and-error design of containers that hold the powder and define the component shape. To overcome these obstacles, the NCEMT has developed a process analysis tool that accurately

predicts the final shape of powder metal (P/M) components consolidated by HIP. Additional machining and material savings occur because the HIP parts are closer to net shape. The cost savings associated with the use of the HIP modeling system in support of the manufacture of components for the New Attack Submarine (NSSN) main sea water system is estimated to be $1.4M per NSSN.

The NCEMT is also improving the manufacturing technology for multi-filament high-temperature superconductor wires–a key component in the development of improved submarine propulsion capabilities. Through the successful completion of a joint effort between the NCEMT and the Coil Development Group, a consortium of Navy Laboratories, Defense Advanced Research Project Agency (DARPA)-funded universities, and commercial companies, the manufacturing technology for mono-filament Bi-2212 wires and tapes in long lengths has now been well established. However, the electrical performance of test magnet coils using these mono-filament tapes indicated that, to reach required critical current densities, a multi-filament conductor must be employed. Successful application of this manufacturing technology to multi-filament wires will ultimately decrease conductor costs from about $100/kAm to $10/kAm and increase production yield by 15%. Further savings in other applications will be realized by enabling reductions in the size and weight of motors and generators, improving motor efficiency, decreasing electrical losses, and simplifying refrigeration requirements. ■

AIRCRAFT

The NCEMT integrates process modeling, product analysis, and process control strategies to meet the need for lightweight and affordable aircraft components.

For example, by applying a knowledge-integrated methodology, the NCEMT optimized the solution treatment process thus reducing by 50% the heat treatment time of complex-shaped superalloy turbine airfoils. This new technology will save an estimated $2.5 million in heat treating costs for Navy F404 and F414 engines over the next seven years. This methodology utilizes an advanced computer modeling code, previously developed by the NCEMT,

to optimize heating rate and solution temperature thereby reducing total processing time and production costs. The methodology is applicable to all superalloys and has been implemented in production by leading aerospace casting companies, PCC Airfoils, and Howmet.

As a follow-on effort, the NCEMT is currently developing a similar knowledge-integrated process technology to optimize the aging process of superalloy turbine airfoils. An additional $1.9M in savings is expected when this technology is implemented in the manufacture of turbine airfoils for Navy F404 and F414 engines.

The NCEMT is developing methods to reduce the acquisition cost of Navy aircraft, for example, by replacing fabricated/assembled wrought aluminum structural components with optimized aluminum castings. By vertically integrating component design and casting process design, optimum structures and mechanical performance are assured. While the technology is generic, the NCEMT will demonstrate the technology on mission critical weapons pylons on the F/A-18E/F fighter aircraft.

In a previous effort, the NCEMT established powder injection molding (PIM) processing parameters for the manufacture of Navy jet engine components from 17-4PH stainless steel and Inconel 718. This will result in savings of $1.5M for the V-22 Osprey tilt rotor aircraft and projected total life-cycle cost reductions of $15M for the Joint Strike Fighter. Based on this success, the NCEMT is now teaming with industrial partners including Pratt & Whitney, PCC Advanced Forming Technology, and Allison Engine Company to apply PIM processing to titanium alloys for turbine engine fasteners and brackets.

Because jet engines operate under very demanding conditions, the NCEMT focuses significant efforts on improving the reliability of components in addition to reducing cost. For example, an in-service titanium disk failure caused by a melt-related defect can lead to the catastrophic loss of an aircraft. To reduce the probability of such a loss, the NCEMT is working with industry to improve the quality of aerospace materials produced by the plasma arc cold hearth melting (PAM) process. This will ensure consistently defect-free titanium alloys for military and commercial aircraft engines. Specifically, improved reliability is expected for F404 and F414 engines for the Navy F/A-18

aircraft and F110 and F119 engines for the Air Force F-15, F-16, and F-22 aircraft.

Building on the successful work of GE Aircraft Engines, performed in a previous Air Force MANTECH project, the NCEMT is optimizing process parameters for the PAM process through computer simulation of the refining and casting steps. These optimized parameters will lead to higher material cleanliness and, therefore, greater reliability and longer service life.

The simulation system models the plasma torch, refining hearth, and ingot solidification. Collectively, these models constitute a comprehensive package useful to titanium material suppliers for many production applications. The completely validated modeling package can also be applied to other secondary remelting processes such as electron beam cold hearth melting (EBM), vacuum arc remelting (VAR), and electroslag remelting (ESR).

The NCEMT has developed enabling technologies for the cost-effective superplastic forming (SPF) of aluminum aircraft assemblies. Through its ability to form complex-shape components and reduce the number of parts and assembly requirements, SPF processing is ideally suited for lightweight and affordable aerospace components. However, expensive trial-and-error design, engineering, and fabrication methods have made SPF application cost-prohibitive.

The NCEMT, working with Boeing St. Louis, recently completed the development and demonstration of a modeling tool that enables manufacturers to design an optimum SPF production schedule. The modeling tool takes into consideration not only metal flow, but also grain growth and cavitation during production. As a result, a 50% manufacturing cost reduction is projected for aluminum aircraft assemblies used in weapons systems.

This improved SPF technology, like most NCEMT accomplishments, reduces the risks associated with the design and fabrication of components for Navy as well as commercial aircraft. ■

ORDNANCE

Significant savings can be achieved by improving the manufacturing processes for DOD missile and ordnance components. Optimized manufacturing practices not only lower acquisition costs but also ensure reliable performance.

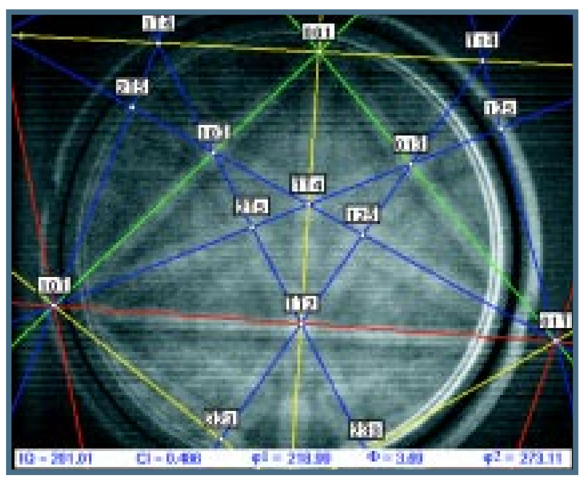
For example, conventional methods used to manufacture missile engine components, such as complex single crystal rotor assemblies, while technically feasible, have become prohibitively expensive. In response, the NCEMT is developing techniques to enable bending simple flat-cast bladed platforms into the appropriate curvature for attachment to the rotor disc. This approach will reduce component manufacturing cost by an estimated 30%. The use of these formed single crystal components in the Tomahawk Cruise Missile gas turbine engine will also allow an increase in operating temperature of 100–150°F, thereby increasing engine thrust by 25% and reducing specific fuel consumption by 5%.

In another effort, the NCEMT is developing technology to reduce the cost of tracers, flares, and infrared counter-measures manufactured from atomized magnesium powder. As munitions procurement has continued to decrease, the price of atomized magnesium has risen to over $13 per pound. To reverse this increase, the NCEMT is developing an improved atomization nozzle which will increase powder yield from 22 to 40% and result in expected annual savings of $1M to $2M per year. The atomization nozzle was designed using computer-based models to simulate both the fluid dynamics of the atomization gas and the break-up of the molten magnesium stream into powder particles. Initial tests have verified the ability to control powder size distribution and thus optimize yield.

Significant performance gains in advanced gun systems are expected as a result of NCEMT improvements in gun barrel technology. Current efforts focus on producing an optimized barrel capable of utilizing a higher impetus propellant with long bursts at high rates of fire, thus increasing both lethality and stand-off distance. Successful implementation of a refractory liner will improve resistance to erosion and reduce interaction with the high-temperature, high-pressure gases generated by the burning propellant. Use of refractory lined barrels will also extend the life of barrels when using conventional propellants, leading to annual savings of $5M. These performance advantages and cost savings will benefit the Navy and other warfighters as well.

The NCEMT is developing the technology to reduce the cost of both conventional and advanced performance guns through the application of improved bore coating techniques. Conventional methods used to protect ordnance from wear and erosion, such as electroplating, have become cost

prohibitive due to tightening environmental and occupational safety regulations. The NCEMT is working with the Battelle Pacific Northwest National Laboratory, the Lawrence Livermore National Laboratory, and the National Defense Center for Environmental Excellence to apply coatings which meet or exceed the properties of electroplated hard chromium while enabling full environmental compliance.



The new bore coating will significantly reduce the cost of ordnance, not only by satisfying environmental regulations, but also by extending the lifetime of gun barrels. Specifically, successfully implementing this alternative surface treatment process will result in cost savings in excess of $1M per year for a production lot of 10,000 medium caliber weapons, such as the USN Phalanx and the U.S. Army Bushmaster.

LEVERAGING

One of the ways the NCEMT enhances the capabilities of the U.S. industrial manufacturing base while meeting Navy needs is by adapting technologies developed by the NCEMT for broader applications. Leveraging previously developed technologies reduces the risk of adopting new practices by avoiding initial development costs and decreasing implementation obstacles.

For example, in an effort sponsored by the Air Force, the NCEMT and industrial partners enhanced the processing techniques for titanium matrix composites (TMC). This technology was initially developed to capitalize on the high-strength, high-stiffness properties of TMCs for turbine engine components, specifically for the large rotating hollow fan blade for the Pratt & Whitney 4000 class engine. Because the processing solutions developed through this program are generic in nature, they are applicable to other TMC assemblies and structures in DOD and civilian aerospace applications.

The NCEMT is also leveraging the results of a recent decoating project to benefit a number of Army facilities. This project demonstrated that a pulsed optical energy decoating system can remove coatings from aircraft without damaging substrate integrity or causing adverse metallurgical effects. Application of this technology reduces by approximately 90% the waste associated with decoating weapons systems during maintenance, as compared to decoating by chemicals or media blasting. The NCEMT is performing pre-production assessments at the Corpus Christi Army Depot. Candidate parts are being treated and evaluated prior to placing a production unit in service at the facility for full-scale demonstration.

In another effort at the Federal Industrial Supply Center–Puget Sound, the NCEMT is taking advantage of advanced electronic

Powder Compaction Simulation

The NCEMT Powder Compaction Simulation (PCS)™ software offers a means to optimize the parameters of the press and sinter process. Currently, over 40 military and domestic powder metallurgy (P/M) manufacturers rely on PCS™ to decrease costs by reducing the need for trial-and-error process design.

The PCS program predicts powder density variation in green P/M compacts during the compaction and ejection cycles. This two-dimensional axisymmetric simulation tool also predicts stress distributions within the compact and tooling, as well as deflection of the dies and loads on the press.

Application of PCS not only reduces fabrication cost, but also improves the quality of the finished part.

commerce capabilities to electronically disseminate data to a larger vendor base. This enables Navy procurement offices to broadcast their requirements to the vendor community more efficiently and affordably.

The NCEMT is applying its technical developments to other DOD programs. By modifying RAPID/CAST®, an advanced solidification modeling software, the NCEMT developed optimization tools for pressure infiltration casting. The new modeling software, called RAPID/PIC®, has been used by Triton Systems in support of a Navy Small Business Innovative Research project to manufacture advanced avionics packages.

Many of the NCEMT training programs also find widespread application. For example, in response to the imminent closing of the Cecil Field Naval Air Station and the Orlando Naval Training Center, NCEMT capabilities are being used in support of the implementation and operation of comprehensive retraining services for displaced Navy workers. The program, operated through the Florida Community College of Jacksonville, features a sophisticated computerized system which compares an individual's current job skills against existing employment opportunities. This system is applicable not only to other defense base closures but also to any industrial downsizing requiring the transition from military to commercial manufacturing.

Training materials are available in a variety of formats, mechanisms, and delivery techniques, and are specifically designed to focus on the cost-effective procurement of weapons systems by Navy personnel, while strengthening the industrial base through a more knowledgeable workforce and enhancing industrial competitiveness through increased agility.

Casting Design

RAPID/CAST®, a 3-D casting design software package is widely used in military and industrial installations to rapidly define optimum design and casting parameters. RAPID/CAST®, incorporates fundamental principles calculations coupled with advanced computer visualization to provide a tool that minimizes trial-and-error in casting process design. Use of RAPID/CAST® leads to shorter development time and decreased costs to produce defect-free castings for many defense and commercial applications.

RAPID/CAST® consists of three modules that provide comprehensive optimization and validation of casting process designs. Solidification kinetics calculations also determine metallurgical features such as grain size and microstructure. Modulus-based calculations give "first guess" solutions in minutes.

RAPID/CAST® has been used to design and analyze a wide range of castings for industry and the military. The Naval Foundry and Propeller Center is utilizing RAPID/CAST® to define the casting process for the propellers on the New Attack Submarine (NSSN). Alcoa, as well as a DARPA-funded casting consortium led by General Electric, also relies on RAPID/CAST® for casting process optimization.

Technology Transfer Activities

ACTIVITIES

The NCEMT plans specific technology transfer activities at the onset of every project undertaken. This process includes identifying anticipated key technical developments and who among Navy, government, and industrial organizations may benefit from them. Appropriate means for transitioning the technology to the end user are also selected. These include direct work with the end user through users groups, workshops, seminars, and hands-on training, as well as broad-based information dissemination through exhibits, project demonstrations, interactive electronic databases, publications, and videos. The following are highlights of 1997 formal technology transfer activities.

Thermomechanical Processing: On May 21, 1997, government and academic personnel attended a users group meeting which provided an overview of thermomechanical processing techniques used in the production of Navy and DOD components.

Metalforming Experiment, Analysis, and Application: On June 11–13, 1997, the NCEMT presented and demonstrated state-of-the-art methods to solve industrial metalworking problems in the areas of forging, rolling, extrusion, and sheetforming of conventional steel and aluminum alloys, as well as superalloys and intermetallics. The presentations focused on process optimization using advanced physical and numerical modeling techniques.

Intelligent Processing of Materials (IPM): The NCEMT hosted a Bi-2212 High Temperature Superconductor (HTS) Manufacturing Technology Development workshop on July 23, 1997. This annual workshop reviewed and demonstrated the application of IPM to the manufacture of superconducting wire.

Enhanced Powder Metallurgy (P/M) Processing of Superalloys: On August 26–27, 1997, the NCEMT and the Metal Powder Industry Federation jointly hosted an intensive workshop. Attendees from the military and industry gained valuable insights in computer modeling techniques for P/M applications.

Manufacturing Technology for Aerospace Materials: This briefing, held August 20–21, 1997, focused on NCEMT accomplishments and featured keynote speakers from the Navy and industry who discussed Naval aviation advanced materials needs and the insertion process for advanced materials production. The event included two end-of-project demonstrations. The technologies developed under the *Powder Injection Molding (PIM) of Turbine Engine Parts* project were demonstrated, including the molding, sintering, and heat-treating of 17-4 PH stainless steel and Inconel 718. The presentation also focused on intelligent processing of materials for PIM, mold fill process simulation, and a computerized system for mold design. Representatives from Pratt & Whitney and Allison Engine presented an overview of their experience in substituting PIM for wrought technologies and the associated cost benefits.

The technologies developed under the *Development of Hot Isostatic Pressing Modeling System for Large Complex Parts* project were also demonstrated. This activity featured computer simulation of several parts to illustrate various applica-tions of this advanced modeling process. The event also detailed the technical problem that prompted development of the model, as well as development techniques and materials testing and properties requirements for the model input. ■

National Center for Excellence in Metalworking Technology (NCEMT)

Operated by:

Concurrent Technologies Corporation

for the:

U.S. Navy Manufacturing Technology (MANTECH) Program

For more information, contact:

NCEMT Information Services
Concurrent Technologies Corporation
1450 Scalp Avenue
Johnstown, PA 15904
Phone: (814) 269-2731
Fax: (814) 269-6480
Internet: faher@jst.ctc.com

CTC® Concurrent Technologies Corporation